



## Our Solar System Through the Eyes of Scientists Grades 1–3 Lesson 6 (Activities 1–5)

### LESSON

# 6 Landforms and Canyons

## Activity 1 – Pre-Assessment

### Picture This!

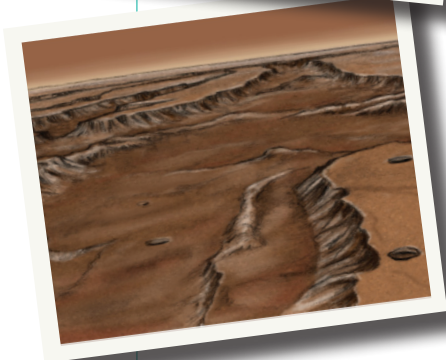


Activity Time  
45 minutes

#### Introduction for Teachers

One of Earth's natural wonders is the spectacular Grand Canyon in Arizona. Canyons exist on other planets, too. One of the grandest canyons of all is Valles Marineris, on the planet Mars.

Meet Dr. Robert Anderson; Scientist, Geologist, and Rock Man at NASA's Jet Propulsion Laboratory in Pasadena, California. Learn about Dr. Anderson's exciting work studying rocks, canyons, and other landforms here on Earth and on other planets. What do your students understand about rocks and how canyons form? Your students can build a "Big Dig" model to show the effects of water on land and illustrate how canyons form here and elsewhere. Your students will learn how moving water changes the land. Besides this, your students will learn to think like scientists, using notebooks to write and draw their observations and form new questions about what they have seen.



#### Come In!

Use images like a scientist to investigate one of Earth's seven natural wonders, the spectacular Grand Canyon in Arizona, and the grandest canyon of all, Valles Marineris, on Mars. Students will meet an inspirational NASA Jet Propulsion Laboratory geologist, Dr. Robert Anderson.

#### Intended Curriculum

##### Big Idea

Everything moves and everything changes in our solar system, including what we know about it.

##### Science Objectives

Students will:

- "Read" pictures and write about what they notice.



Materials and Teacher Preparation

Materials

- Illustrations of Earth’s Grand Canyon and Valles Marineris on Mars — one of each for each student (see Resource Materials)
- “Meet the Scientist” segment below
- Writing materials — pencils, crayons, markers, colored pencils
- Glue and scissors
- Science Notebooks
- Solar System folder for each student
- Science Word Wall chart
- “What Scientists Do” chart

Teacher Preparation

Distribute writing materials and illustrations to students. Read aloud or make copies for students to read (with a partner) the “Meet the Scientist Story” of Dr. Robert Anderson.

Meet the Scientist

The Story Begins! Meet Dr. Robert Anderson

Have you ever visited another planet? No? Well, so far, neither has anyone else! Scientists and engineers send spacecraft far into our solar system to serve as “eyes” and “ears.” Scientists wait with excitement to see what their spacecraft is seeing. When the pictures finally do arrive, scientists cannot wait to see what they show about our solar system. You will meet an exciting scientist and hear about his science notebook. Each student will get two pictures: one of the Grand Canyon and another of a canyon on Mars. Like a scientist, you will write in your notebook about what you notice about these pictures.

As a boy, Dr. Robert Anderson thought it would be cool to walk on the Moon like the Apollo astronauts. Then he read a cartoon about a scientist. The scientist was having all the fun. Now Dr. Anderson is a famous scientist himself at the Jet Propulsion Laboratory in Pasadena, California. He sees the wonders of Mars using rovers. A Mars rover is a vehicle controlled from Earth. Mars is very, very far away!!

Wouldn’t you think that a scientist like Dr. Anderson would have earned good grades in school? Not true! Because of a learning problem, Dr. Anderson had trouble reading and writing. In order to achieve his dream of being a scientist,

he allowed himself extra time to study and to complete homework. His hope for you is that you work hard and never give up your dreams. Why do scientists use notebooks? Here is a quote from Dr. Anderson: “Science notebooks are important to being a good scientist. A notebook helps you remember what you have done. It reminds you about what you have not done. A science notebook keeps all your work in one place. Scientists always have their notebooks ready! What do you think a scientist like Dr. Anderson might put in his notebook?



Right: Dr. Robert Anderson, age 8

Dr. Anderson works on Mars rovers such as this one being tested at JPL.



Discussion Prompt

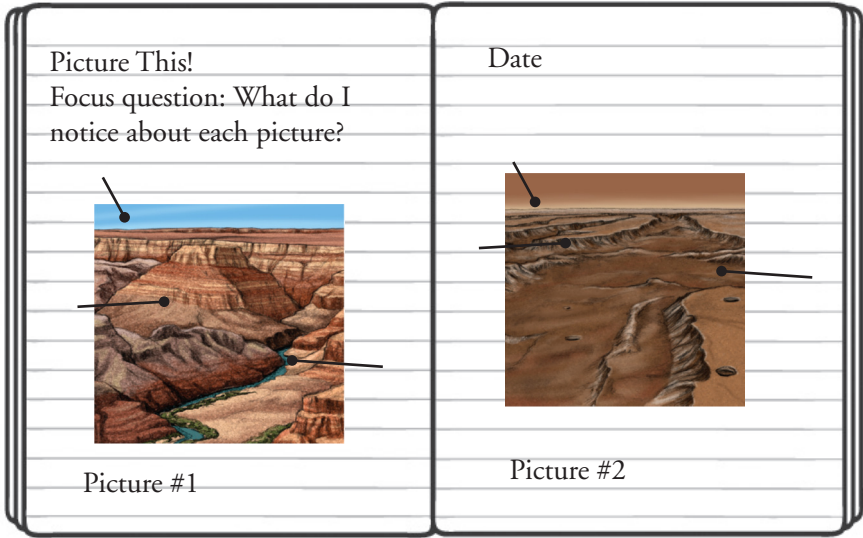
- Introduce new question for discussion: What is the difference between a scientist, an engineer and an astronaut?
- Would you rather be an astronaut, an engineer, or a scientist? Why?



Science Notebooks

Let’s Begin Our Notebooks Activity

Write in the title (Picture This!), date, and focus question (“What do I notice about each picture?”) Paste picture #1 in the middle of the page. Write words, phrases or sentences around the picture as much as you can to tell someone reading your notebook about what you see. Tell about the colors and the shapes. Where have you seen something like each picture? Repeat for picture #2.



Science Word Wall Additions

canyon — deep trench, gorge, steep sides  
Grand Canyon — a canyon in Arizona  
Valles Marineris — a canyon on Mars  
landforms — list (Mountains, volcanoes, beaches, sand dunes, canyons, deserts, islands, cliffs, and many others!) and draw examples; cut out and paste on the Science Word Wall Chart

Making Meaning

- Have students refer to their notebooks.
- Have students share their words, phrases or sentences. Make a class list for each of the pictures from the shared words, phrases or sentences.
  - What are landforms? (Mountains, volcanoes, beaches, sand dunes, canyons, deserts, islands, cliffs, and many others!)
  - What kind of landform is in the pictures? (Canyons: with deep, steep sides.)
  - One picture is an Earth canyon and the other is a picture of a canyon on Mars. Which one is the Earth canyon? Which is the Mars canyon? Why? What do you see that makes you think one is on Earth and the other is on Mars? Which picture has a river? Are there signs of life? Scientists look for Earth-like landforms as they explore our solar system. What do you notice about the skies?
  - Have students label each picture as Earth: Grand Canyon and Mars: Vallles Marineris.
  - Refer to the “What Scientists Do” chart: How did this activity help your students think and be like scientists? Compare and contrast chart with student observations, recording, notebooks, and discussion activities.

Teacher Pre-Assessment Evaluation

- Objectives taught in this lesson may be used to create rubrics for evaluating student writing in notebooks and represent the pre-assessment for this unit. Objectives that will be taught in this lesson include:
- Canyons are found on Earth and on other planets.
- Canyons can be formed by water erosion (wearing away) or by forces beneath the surface.
- Canyons are deep gorges: trenches with steep, rocky sides. Different Explanations exist about how they formed.
- The Grand Canyon is found on Earth and is famous for its beautifully exposed layers of rock due to erosion. The layers tell much of Earth’s ancient history.
- Valles Marineris on Mars is our solar system’s largest canyon and was most likely caused by forces deep beneath the surface. It is immense! Earth’s Grand Canyon would be a speck in comparison.

Standards

National Science Standards

- Physical Science: position and motion of objects
- Earth and Space Science: objects and landforms on Earth and on other planets



National Council of Teachers of English (NCTE) Standards for the English Language Arts

- Students read a wide range of print and nonprint text to build an understanding of nonfiction texts and to acquire new information.
- Students apply a wide range of strategies to comprehend, interpret, evaluate and appreciate texts.
- Students adjust their use of spoken, written and visual language to communicate effectively with a variety of audiences and for different purposes.
- Students employ a wide range of strategies as they write and communicate with different audiences for a variety of purposes.
- Students conduct research by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data to communicate their discoveries.
- Students use spoken, written, and visual language to accomplish their own purposes for learning, enjoyment, persuasion and the exchange of information.

Acknowledgments

Thank you Dr. Robert Anderson from NASA’s Jet Propulsion Laboratory, and a Mars Exploration Rover scientist, for inspir-ing students with your story.

Further Exploration

To learn more, please visit these websites —  
JPL’s Mars Exploration Program website —  
<http://mars.jpl.nasa.gov/>  
Mars Exploration For Kids —  
<http://marsprogram.jpl.nasa.gov/participate/funzone/>  
Cool Cosmos for Kids: —  
<http://coolcosmos.ipac.caltech.edu/>  
Cool Cosmos for Kids: Is there Really a Giant Canyon on Mars?  
[http://coolcosmos.ipac.caltech.edu/cosmic\\_kids/AskKids/mars\\_canyon.shtml](http://coolcosmos.ipac.caltech.edu/cosmic_kids/AskKids/mars_canyon.shtml)

Teacher Background

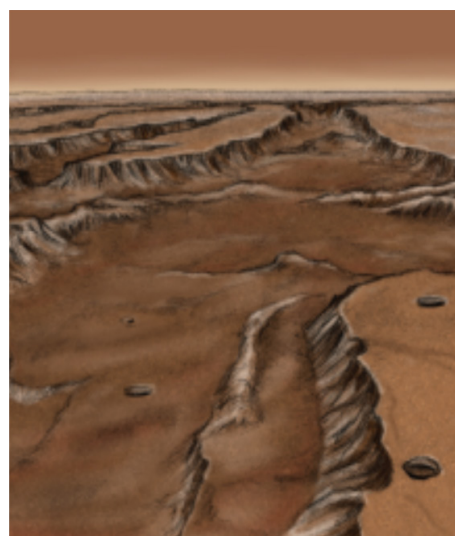
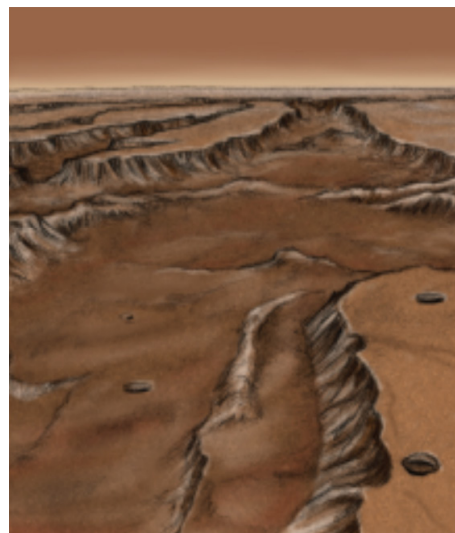
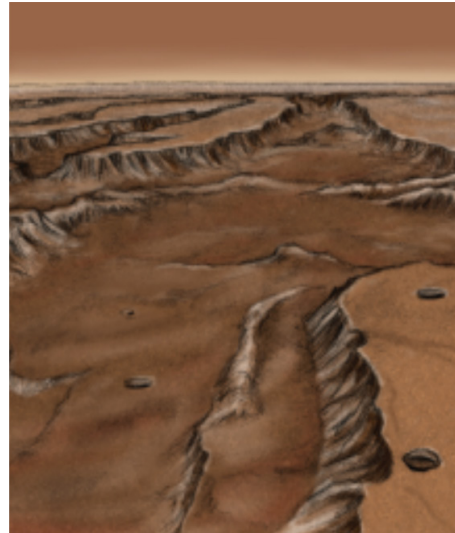
- Refer to Reading Adventure Books, Lesson 6 Activity 4
- Grand Canyon: Book 1
- Primary Reading Adventure: Look Down, Way Down Deep!
- Upper Grades Reading Adventure: Steep, Rocky and Narrow!
- Valles Marineris: Book 2
- Primary Reading Adventure: Swirling Red Storm
- Upper Grades Reading Adventure: Beneath the Cinnamon-Colored Storm



**Resource Material Lesson 6 - Activity 1**

Two landform images

One of each image per student



LESSON

# 6 Landforms and Canyons

**Activity 2 – Try This!**



Activity Time

Day 1 – 45 minutes

Day 2 – 45 minutes

## The Big Dig!

### Introduction for Teacher

How did the Colorado River carve out a mile-deep canyon that exposed layer upon layer of beautifully colored rocks? Build a “Big Dig” model that demonstrates the effect of water on the land, and learn more about Dr. Robert Anderson’s work. (This is a two-day activity.)

### Intended Curriculum

#### Big Idea

- Everything moves and everything changes in our solar system, including what we know about it.

### Science Objectives

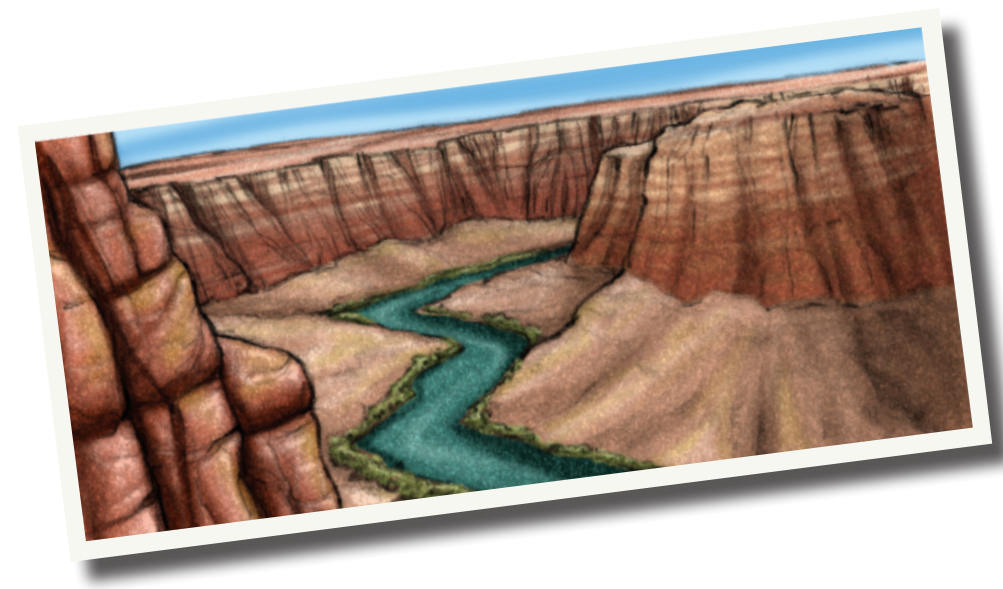
#### Students will understand that:

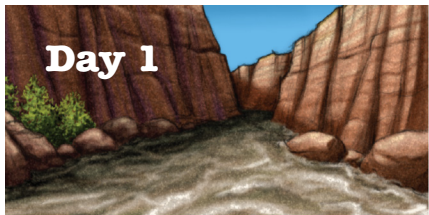
- Erosion is the wearing away of the Earth.
- Canyons can be carved out (eroded) by running water.
- Models are important tools of science.

### Language Arts Objectives

#### Students will use notebooks to:

- Produce accurate descriptions of results.
- Compare what they used to think to what they understand now.





**Materials and Teacher Preparation**

- Word Wall Class Chart

**Materials for each student:**

- Science Notebooks
- Pencils, markers, glue, scissors
- A copy of the procedure diagram for each student (see Resource Material)

**Materials for each group of 3 to 5 students:**

- 1/2 liter bottle filled with water
- One 12- or 16-oz. styrofoam cup
- 3/4 liter of damp (not wet) fine sand
- 1 gallon (1.89 liter) milk carton with one side cut out (see diagram)
- Catch basin (for example, a bucket)

**Teacher Preparation**

You may wish to poke holes in the styrofoam cups ahead of time (see diagram).

**Lesson Procedure**

Read to your students:

**The Story Begins!**

My name is the Colorado River. A long, long time ago I began to flow across a high flat land in Arizona. Today I am still on the move. How did I change the land? Like a scientist, you will build a model showing what happened when I flowed (ran) over the land.

We are going to do an activity to see what happens when water flows over land.

This is what our model is going to look like —

- Pass out and go over the procedures page.
- Have students organize their notebooks (see Science Notebooks page for sample).
- Have one student from each group (three to five students) collect the materials. (The entire activity can take place outdoors).
- Have students set up the model. The teacher may do this with students, one step at a time.

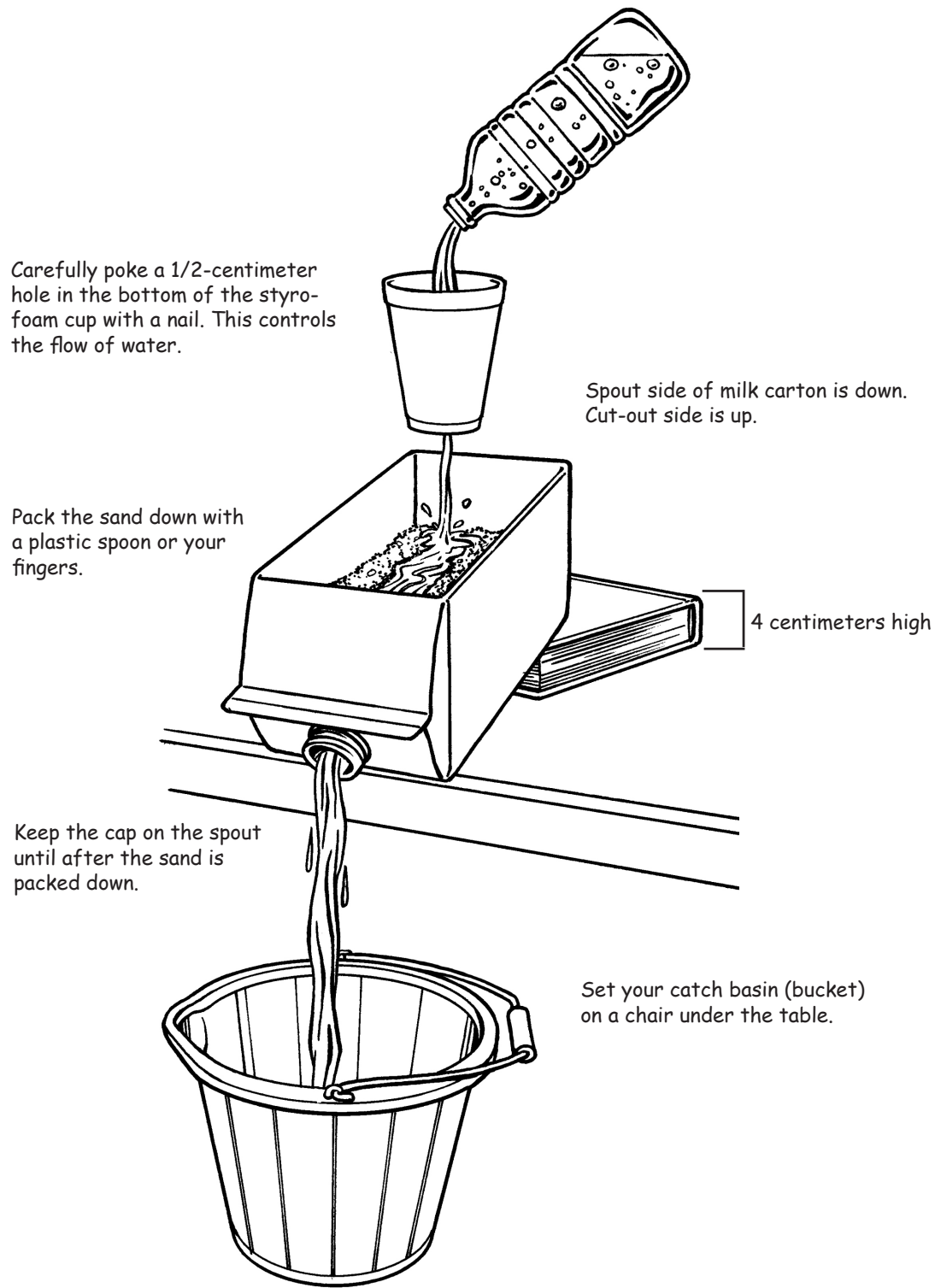
Check the set up and have the students do the activity. Remember to take the lid off the milk carton spout AFTER packing the damp sand and before pouring the water!

Have students enter data in their notebooks. Place the Science Word Wall Chart where students can see it.

Procedure diagram

**Resource Material Lesson 6 - Activity 2**

Note: Save the sand, it is used again in the next activity.





Science Word Wall Additions

geologist — a scientist who studies landforms of tje Earth and other planets (how they came to be and what processes formed them)

Science Notebooks

A Notebook Lesson from Dr. Robert Anderson

A well-organized notebook will save you from being upset if you cannot remember what you have done. You may have to do things over again if you cannot remember what you did before. Not fun! As a geologist, I spend days walking around outside col-lecting rocks and soil. Once I was in the field making a map, and I did not write or draw very much in my notebook. Two weeks later I had to turn in my work. My notebook did not help! I had to go back 200 miles and do the work all over again. It took me all weekend. I lost time and having fun with my friends. This taught me a valuable lesson. The next time I was careful with my notebook and the teacher told me, “Excellent work!” It was just one of those lessons I had to learn the hard way.



Students, Start Your Notebooks!

- Here is an example of a possible way to organize what the students saw when they were working on the model. Encourage the use of student-developed ways to organize their notes. Do you have a title for your drawing?

Title: The Big Dig	Date:
Focus Question: How does moving water change the land?	
Drawing of results	Write about what happened:
	First
	Next
	Then
	Finally



Discussion Prompt

Have students refer to their Science Notebooks.

- What do you know now?
- What happened when the water ran down the sand (land)? *(Have students describe in sequence — First...Next...Then...Finally...)*
- How do you think what we did is like what might have happened in the real grand Canyon? *(At one time there was no Grand Canyon. Like our model, the river had to dig out the canyon and wear it away [erosion]. The river carried away the sand [sediments]. The river dug a deep canyon. Much of what was carried away went out into the ocean [the Gulf of California]. When Dr. Anderson looks at the rocks and fossils in the Grand Canyon, he can tell that the land was once covered by seas.)*
- We made a model of how the Grand Canyon might have been created. Our model is much smaller than the real canyon. What do we mean by a “model?”
- Why do scientists use models? *(Scientists cannot always work with the real thing. Real things might be too big, too small, too hot, or too far away.)*
- What models have you made? *(cars, clay, solar system, etc.)*
- What parts of our model are like the Grand Canyon? *(The bottle of water is the Colorado River; the sand in the carton is the high land; the bucket is where the sand [sediments] goes [into the Gulf of California]).*
- What do you know now that you did not know before?

Science Word Wall Additions

erosion — wearing away of the land  
layers — material covering a surface  
model — a representation of a real thing; something smaller or larger than the real thing  
sediments — small particles of sand, plant and animal material  
fossils — remains of animals saved in rocks  
sea — a large area of salt water (an ocean)



## Science Notebooks

### Let's Begin Our Notebook Activity

What have you learned?

- Turn back to Activity 1 in your notebook.
- What do you know now that you didn't know before?
- What picture shows the Grand Canyon? What do you see in the picture now that you didn't see before? (*A canyon with colorful layers, deep sides [cliffs] that the Colorado River dug out, plants, a place where fish, animals, and birds might be able to live, rocks, soil, sand, the river looks muddy, many different colors, a blue sky, etc.*)
- Have students share notebooks with a partner. Give students a few minutes to add to their notebooks.
- Relate the lesson to the Big Idea:
  - Everything moves and everything changes in our solar system including what we know about it.
  - What moves and changes in the Grand Canyon? What questions do you still have?

## Formative Assessment

“What I Used to Think” and “What I Know Now” is a post-assessment of the Grand Canyon activity objectives.

## Acknowledgments

For the adaptation of canyon carver and public domain photographs: U.S. Department of the Interior, National Park Service, Geology Lesson Plans

## Further Exploration

Comparative geology of the Solar System —

<http://education.gsfc.nasa.gov/ess/Units/Unit5/U5L17A.html>

Martian terrain —

[http://mars.jpl.nasa.gov/gallery/martianterrain/athabasca\\_100.html](http://mars.jpl.nasa.gov/gallery/martianterrain/athabasca_100.html)

NASA and geology —

<http://www.nasa.gov/audience/forstudents/k-4/dictionary/Geology.html>



LESSON

# 6 Landforms and Canyons

## Activity 3 — Do This!

## The Big Zipper!



### Introduction for Teachers

Investigate the grandest of all canyons in the Solar System! Valles Marineris on Mars is much grander than Earth's Grand Canyon in every respect — it is wider, longer, deeper, and older. A place of puzzles and few answers, Valles Marineris is long enough to stretch from California to New York.

Activity Time

Day 1 – 45  
minutes

Day 2 – 45  
minutes

### Teacher Tip

This is a two-day activity and includes two optional readers (see Resource Material at the end of the activity) that you may wish to copy and hand out to your students and/or read to them. The readers are “Look Down, Way Down Deep!” (about the Grand Canyon) and “Under the Red Dust Storm” about Mars and Valles Marineris



## Intended Curriculum

### Big Idea

- Everything moves and everything changes in our solar system, including what we know about it.

### Science Objectives

Students will understand that:

- Valles Marineris is huge.
- Enormous forces deep inside a planet can lift or push up the surface.
- Breaking or rifting is one example of a surface change resulting from uplift.

### Language Arts Objectives

Students will use notebooks to:

- Produce accurate descriptions of results.
- Compare what they use to think to what they understand now.



### Materials and Teacher Preparation

- Science Word Wall Chart
- Science Notebook — one per student
- Pencils and a red and blue pencil/marker/crayon; scissors, glue
- Lesson Steps page — one per team of three to four students
- “Let’s Get Roving” — one per student (see Resource Material)
- Class chart — paper and markers
- Aluminum pan with flexible bottom (gas grill drip pan, 8-3/8 inches by 5-3/8 inches by 1 inch deep) — one per team
- Sand left over from Activity 2 — sand needed for nine teams of students is about 1 gallon
- Rubber or metal washers (2-inch size) from home/garden supply store — 3 or 4 per student team

### Teacher Preparation

- Fill aluminum pans about 2 centimeters deep with damp (not wet) fine sand; using about 2-1/2 cups per pan, pack down.
- Pass out copies of the Lesson Steps page and go over it with the students: What are we going to do first? Next? Then? Finally...? Students work in teams of 3 to 4.

### Lesson Procedure

#### The Story Begins!

- Read to your students: “Let’s Get Roving”
- Follow the Lesson Steps. The teacher may direct the activity with students one step at a time. Discuss new words (such as washer, rifts, etc.). Have students make notebook entries as each step is completed.

### Lesson Steps

- (The teacher may have already completed this step.) Fill a flexible aluminum pan with about 2 centimeters of damp sand: about 2-1/2 cups. Pack down.
- Place a 2-inch washer on a flat surface. Center the pan over the top of the washer. The washer will create “uplift.” Observe, draw, and write about the results in your Science Notebook.
- Carefully remove the pan without disturbing the previous results. Add another washer on top of the first one and center the pan over the same place. Observe, draw, and write about the results in your Science Notebook.
- Add a third washer onto the stack. Center the pan over the same place. Observe, draw, and write about the results in your Science Notebook.



### Science Notebooks

#### Let’s Begin Our Notebook Activity

Tell students that they will be drawing and recording the results of the procedure.

- For one washer, use a black or gray pencil to draw and record the results.
- For two washers, use a red pencil to draw the results.
- For three washers, use blue pencil to draw the results.
- 

Have students make entries as each step is completed.

After entries have been made, have students walk around and observe the results of other groups.

### Science Word Wall Additions

rover — a remotely controlled vehicle

washer, cracks, breaks, rifts, longer, wide, deeper, more, uplifted, pushed





Discussion Prompt

- Have students refer to their Science Notebooks — Fill in the class chart (example below).
- What happened when the surface was lifted up from below?
- How might the huge canyon Valles Marineris have been formed? What does our model tell us?
- Scientists like Dr. Anderson think Valles Marineris was likely formed by huge forces from below lifting the surface and causing breaks, fractures and rifts. Part of the canyon may have also been caused by the surface collapsing downward.

	Team A	Team B	Team C
No washers			
One washer			
Two washers			
Three washers			



Science Notebooks

Let's Begin Our Notebook Activity

What have you learned?

- Turn back to Activity 1 in your notebook.
- Which picture is Valles Marineris? What do you know now that you didn't know before?

Discuss new words and terms with the students.

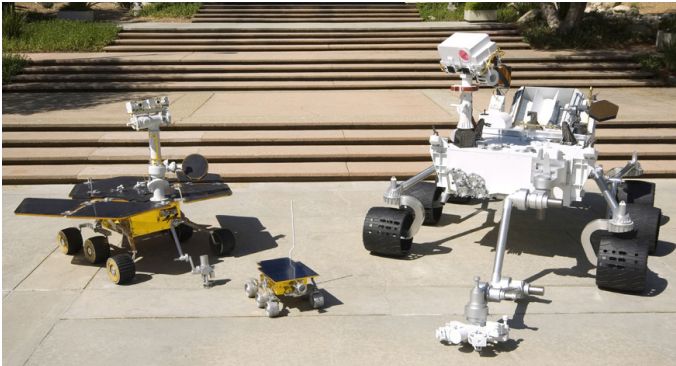
(more, wider, longer, deeper cracks, breaks, rifts, fractures

1 per student

Resource Material Lesson 6 - Activity 3

Let's Get Roving

Here is a picture of three different Mars rovers. Dr. Anderson's favorite thing is to learn about Mars using a rover. Rovers are like small cars with cameras for eyes. Rovers send back pictures to Earth. The pictures show scientists things nobody has ever seen before. The scientists then share what they have seen and learned with us.



Dr. Anderson wrote: "I am seeing an area no other human being has ever seen. It is a very exciting experience!"

Look in your notebook at the pictures from Activity 1. The second canyon is named Valles Marineris. This canyon is on Mars. How does it look like — or unlike — Earth's Grand Canyon?

Valles Marineris would go all the way across the United States. That's HUGE! Some people say it looks like a giant zipper that broke open. What does it look like to you?

Today we are building a model about Valles Marineris. Some scientists like Dr. Anderson think this canyon was caused because something pushed up the surface from below.

What can happen to the surface of a planet when it is pushed up from below?

